

CLAIMS

What is claimed is:

1. A fluid flow control device comprising:
a valve having a fluid inlet, a fluid outlet and a flow path defined therebetween, the valve further including a valve seat in communication with the flow path and a valve stem disposed within a valve seat and cooperatively configured with the valve seat to cause the valve stem to advance or back off within the valve seat responsive to rotation of the valve stem about a first axis;
a gear member coupled to the valve stem; and
a linear positioning member having at least a portion thereof configured to complementarily engage the gear member, wherein the linear positioning member is configured to be displaced along a second axis and cause rotation of the gear member about the first axis.
2. The fluid flow control device of claim 1, wherein the at least a portion of the linear positioning member which is configured to complementarily engage the gear member is configured as a worm gear.
3. The fluid flow control device of claim 2, wherein the worm gear is formed of a material comprising carbon steel and wherein the gear member is formed of a material comprising brass.
4. The fluid flow control device of claim 2, further comprising a linear positioning actuator coupled with the linear positioning member and configured to displace the linear positioning member along the second axis.
5. The fluid flow control device of claim 4, wherein the linear positioning actuator includes a linear positioning stepper motor.
6. The fluid flow control device of claim 5, wherein the linear positioning actuator is configured to be operably coupled with a controller.

7. The fluid flow control device of claim 6, wherein the linear positioning actuator is configured to receive an electrical input signal in the range of approximately 4 to 20 milliamps.

8. The fluid flow control device of claim 7, wherein the linear positioning actuator includes a direct current power supply.

9. The fluid flow control device of claim 8, wherein the direct current power supply includes a transformer configured to be coupled with an alternate current power supply.

10. The fluid flow control device of claim 4, further comprising a frame member coupling the linear positioning actuator to the valve.

11. The fluid flow control device of claim 4, wherein the linear positioning actuator is configured to limit the travel of the linear positioning member along the second axis within a predetermined range.

12. The fluid flow control device of claim 4, further comprising a linear position sensor located and configured to detect a position of the linear positioning member.

13. The fluid flow control device of claim 12, wherein the linear position sensor includes a linear potentiometer.

14. The fluid flow control device of claim 2, wherein the worm gear is substantially rotationally fixed about the second axis.

15. The fluid flow control device of claim 1, wherein the valve is configured to accommodate a fluid flow at a pressure of up to at least approximately 3,000 pounds per square inch.

16. The fluid flow control device of claim 1, wherein the valve is configured to have a flow coefficient of approximately 0.004 C_v .

17. The fluid flow control device of claim 1, wherein the valve is configured to maintain a substantially constant flow rate of fluid flowing therethrough at approximately 1 milliliter per minute or less.

18. The fluid flow control device of claim 1, wherein the valve stem is threadably coupled with the valve.

19. A fluid flow control system comprising:
a controller;
at least one fluid flow control device operably coupled with the controller, the at least one fluid flow control device comprising:
a valve having a fluid inlet, a fluid outlet and a flow path defined therebetween, the valve further including a valve seat in communication with the flow path and a valve stem disposed within a valve seat and cooperatively configured with the valve seat to cause the valve stem to advance or back off within the valve seat responsive to rotation of the valve stem about a first axis;
a gear member coupled to the valve stem; and
a linear positioning member having at least a portion thereof configured to complementarily engage the gear member, wherein the linear positioning member is configured to be displaced along a second axis and cause rotation of the gear member about the first axis.

20. The fluid flow control system of claim 19, wherein the at least a portion of the linear positioning member which is configured to complementarily engage the gear member is configured as a worm gear.

21. The fluid flow control system of claim 19, wherein the controller includes a proportional, integral, derivative (PID) controller in communication with the linear positioning actuator.

22. The fluid flow control system of claim 19, wherein the controller includes a central processing unit and a memory device.

23. The fluid flow control system of claim 19, wherein the controller is operable coupled to at least one input device and at least one output device.

24. The fluid flow control system of claim 19, further comprising at least one sensor operably coupled with the controller, wherein the at least one sensor is located and configured to detect at least one characteristic of a fluid flow associated with the valve.

25. The fluid flow control system of claim 24, wherein the at least one sensor is configured and located to detect at least one characteristic of the fluid flow at a downstream location relative to the valve.

26. The fluid flow control system of claim 24, wherein the at least one sensor is configured and located to detect at least one characteristic of the fluid flow at an upstream location relative to the valve.

27. The fluid flow control system of claim 24, wherein the at least one sensor is located and configured to detect at least one of a pressure, a flow rate and a temperature associated with the fluid flow.

28. The fluid flow control system of claim 19, further comprising a pump configured to provide a fluid flow to the valve.

29. The fluid flow control system of claim 28, wherein the pump is operably coupled with the controller.

30. The fluid flow control system of claim 28, wherein the pump includes an syringe pump.

31. The fluid flow control system of claim 19, wherein the linear positioning actuator includes a linear positioning stepper motor.

32. The fluid flow control system of claim 19, further comprising a frame member coupling the linear positioning actuator to the valve.

33. The fluid flow control system of claim 19, wherein the linear positioning actuator is configured to limit the travel of the linear positioning member along the second axis within a predetermined range.

34. The fluid flow control system of claim 19, further comprising a linear position sensor located and configured to detect a position of the linear positioning member.

35. The fluid flow control system of claim 34, wherein the linear position sensor includes a linear potentiometer.

36. The fluid flow control system of claim 19, wherein the valve is configured to accommodate a fluid flow at a pressure of up to at least approximately 3,000 pounds per square inch.

37. The fluid flow control system of claim 19, wherein the valve is configured to have a flow coefficient of approximately 0.004 C_v .

38. The fluid flow control system of claim 19, wherein the valve is configured to maintain a substantially constant flow rate of fluid flowing therethrough at approximately 1 milliliter per minute or less.

39. The fluid flow control system of claim 19, wherein the worm gear is substantially rotationally fixed about the second axis.

40. The fluid flow control system of claim 19, wherein the valve stem is threadably coupled with the valve.

41. A method of controlling the flow of a fluid, the method comprising:
providing a valve having an inlet, and outlet, a flow path defined between the inlet and the outlet,
and a valve seat in communication with the flow path;
disposing a valve stem within the valve seat;
coupling the valve stem with a gear member;
engaging the gear member with a complementary surface of a linear positioning member;
flowing the fluid through the flow path; and
displacing the linear positioning member along a first axis to rotate the gear member and valve stem about a second axis and displacing the valve stem along the second axis.

42. The method according to claim 41, further comprising forming the complementary surface of the linear positioning member as a substantially helically cut worm gear.

43. The method according to claim 42, further comprising substantially restraining the worm gear from rotating about the first axis.

44. The method according to claim 41, further comprising sensing at least one characteristic of the fluid.

45. The method according to claim 44, wherein sensing at least one characteristic of the fluid includes sensing at least one of a pressure, a temperature and a flow rate of the fluid.

46. The method according to claim 44, wherein displacing the linear positioning member along a first axis is responsive to the detected at least one characteristic of the fluid.

47. The method according to claim 44, wherein sensing at least one characteristic of the fluid includes sensing the at least one characteristic of the fluid at a location upstream of the valve.

48. The method according to claim 44, wherein sensing at least one characteristic of the fluid includes sensing the at least one characteristic of the fluid at a location downstream of the valve.

49. The method according to claim 41, wherein flowing the fluid through the flow path further includes flowing a compressible fluid through the flow path.

50. The method according to claim 41, wherein flowing the fluid through the flow path includes effecting a phase change within the fluid.

51. The method according to claim 41, wherein flowing the fluid through the flow path further includes flowing the fluid at a substantially constant rate of approximately 1 milliliter per minute or less.

52. The method according to claim 41, further comprising maintaining a pressure of the fluid within approximately 3 pounds per square inch of a predetermined pressure.

53. The method according to claim 41, wherein disposing a valve stem within the valve seat further includes threadably engaging the valve stem with the valve.